Conic Projections

Basic conic projections involve the transformations to a cone either secant or tangent to the Earth's surface. Specification of the latitudes of secant intersection are made with the `lat_1=`ϕ_1 and `lat_2=`ϕ_2 parameters ($\phi_1 = \phi_2$ for tangent form). Cylindrical ($\phi_1 = -\phi_2$) or azimuthal ($\phi_1 = \phi_2 = 90°$) limiting forms should not be performed by these projections.

Lambert Conformal Conic Projection

Figure 37: Lambert Conformal Conic projection, with shorelines and 30° graticule. Central Meridian 90° W. and standard parallels at 20° N and 60° N (`+proj=lcc +lon_0=90w +lat_1=20n +lat_2=60n`).

Classifications: Conformal conic.

Available forms: Forward and inverse, spherical and elliptical projection.

Usage and options: `+proj=lcc +lat_1=`ϕ_1 `+lat_2=`ϕ_2 `+lat_0=`ϕ_0

Default values for ϕ_1 and ϕ_2 are respectively 33° N and 45° N (values normally used for maps of the conterminous United States). Limiting forms are Polar Stereographic and Mercator.

Equidistant Conic Projection

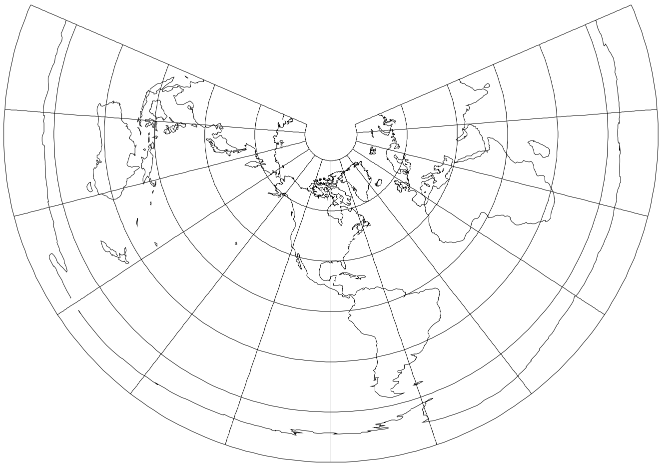

Figure 38: Equidistant Conic projection, with shorelines and 30° graticule. Central Meridian 90° W. and standard parallels at 20° N and 60° N (`+proj=eqdc +lon_0=90w +lat_1=20n +lat_2=60n`).

Classifications: Conic. Neither conformal nor equal area.

Available forms: Forward and inverse, spherical and elliptical projection.

Usage and options: `+proj=eqdc +lat_1=`ϕ_1 `+lat_2=`ϕ_2 `+lat_0=`ϕ_0

Default values for ϕ_1 and ϕ_2 are respectively $29\frac{1}{2}^\circ$ N and $45\frac{1}{2}^\circ$ N. Limiting forms are Polar Azimuthal Equidistant and Equirectangular.

Perspective Conic Projection

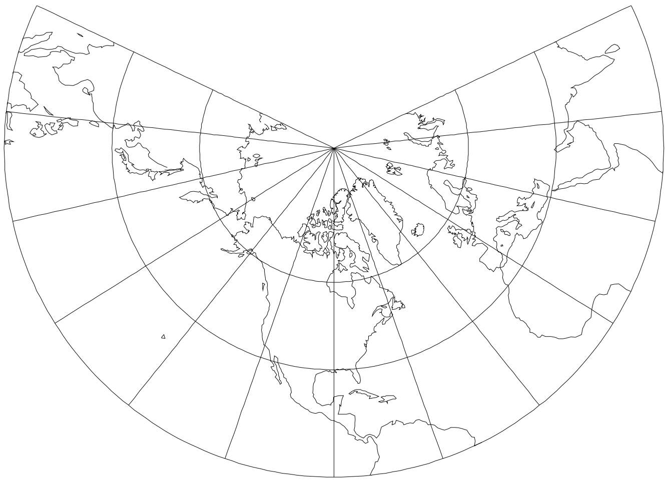

Figure 39: Perspective Conic projection, with shorelines and 30° graticule. Central Meridian 90° W and standard parallels at 20° N and 60° N (`+proj=pconic +lon_0=90w +lat_1=20n +lat_2=60n`).

Classifications: Conic. Neither conformal nor equal area.

Available forms: Forward, spherical projection.

Usage and options: `+proj=pconic +lat_1=`ϕ_1 `+lat_2=`ϕ_2

Default values for ϕ_1 and ϕ_2 are respectively 33° N and 45° N Limiting forms are Polar Gnomonic and Central Cylindrical.

Albers Equal Area Projection

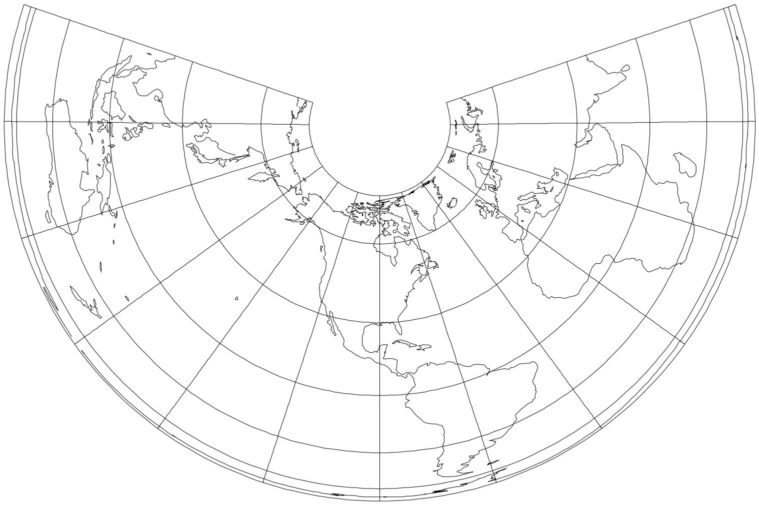

Figure 40: Albers equal area projection, with shorelines and 30° graticule. Central Meridian 90° W. and standard parallels at 20° N and 60° N (`+proj=aea +lon_0=90w +lat_1=20n +lat_2=60n`).

Classifications: Conic. Equal area.

Available forms: Forward and inverse, spherical and elliptical projection.

Usage and options: `+proj=aea +lat_0=`ϕ_0 `+lat_1=`ϕ_1 `+lat_2=`ϕ_2

Default values for ϕ_1 and ϕ_2 are respectively $29\frac{1}{2}^\circ$ N and $45\frac{1}{2}^\circ$ N (values normally used for maps of the conterminous United States).

Lambert Equal Area Projection

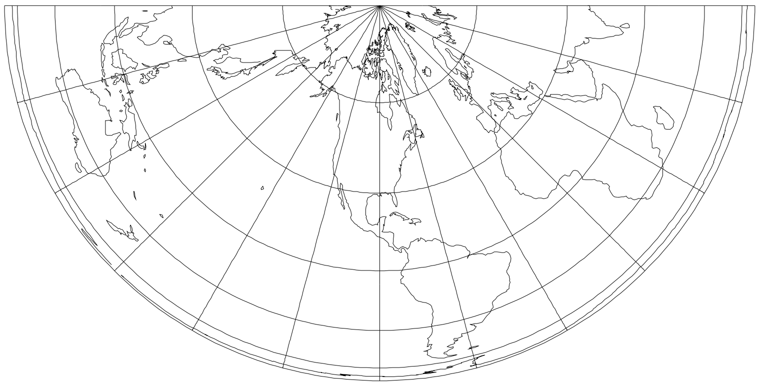

Figure 41: Lambert Equal Area Projection, with shorelines and 30° graticule. Central Meridian 90° W and standard parallel at 0° (`+proj=leac +lon_0=90w`).

Classifications: Conic. Equal area.

Available forms: Forward and inverse, spherical and elliptical projection.

Usage and options: `+proj=leac +lat_1=`ϕ_1 `+lat_0=`ϕ_0 `+south`

Default value for ϕ_1 is 0°. Select parameter `+south` for south polar aspect. Limiting form is Polar Lambert Azimuthal Equal Area ($\phi_1 = \pm 90^\circ$).

Bipolar Oblique Conic Conformal Projection

Classifications: Conformal conic.
Available forms: Forward and inverse, spherical projection.
Usage and options: `+proj=bipc +ns`

Not illustrated. For non-skewed cartesian coordinates select option `+ns`.

Polyconic (American) Projection

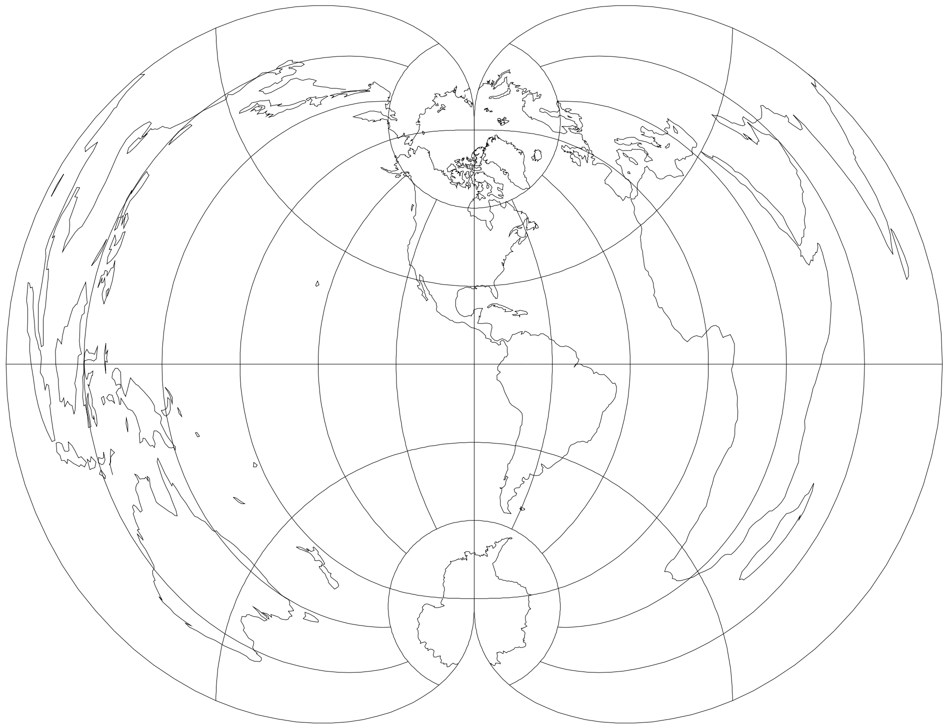

Figure 42: Polyconic (American) projection, with shorelines and 30° graticule. Central Meridian 90° W (`+proj=poly +lon_0=90w`).

Classifications: Neither conformal nor equal area.
Available forms: Forward and inverse, spherical and elliptical projection.
Usage and options: `+proj=poly +lat_0=`ϕ_0

Inverse projection of cartesian coordinates representing λ greater than 90° from λ_0 cannot be performed.

Rectangular Polyconic Projection

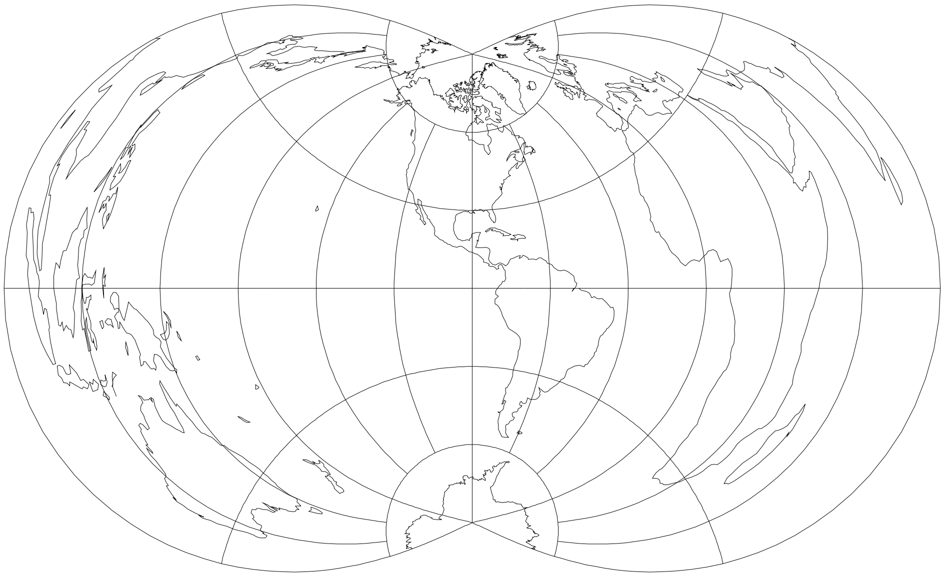

Figure 43: Rectangular Polyconic projection, with shorelines and 30° graticule. Central Meridian 90° W (`+proj=rpoly +lon_0=90w`).

Classifications: Neither conformal nor equal area.

Aliases: War Office (British)

Available forms: Forward, spherical projection.

Usage and options: `+proj=rpoly +lat_ts=`ϕ_s

A latitude of true scale may be specified with `lat_ts=`ϕ_s as shown in figure 44 If not specified, $\phi_s = 0$ is assumed as shown in figure 43.

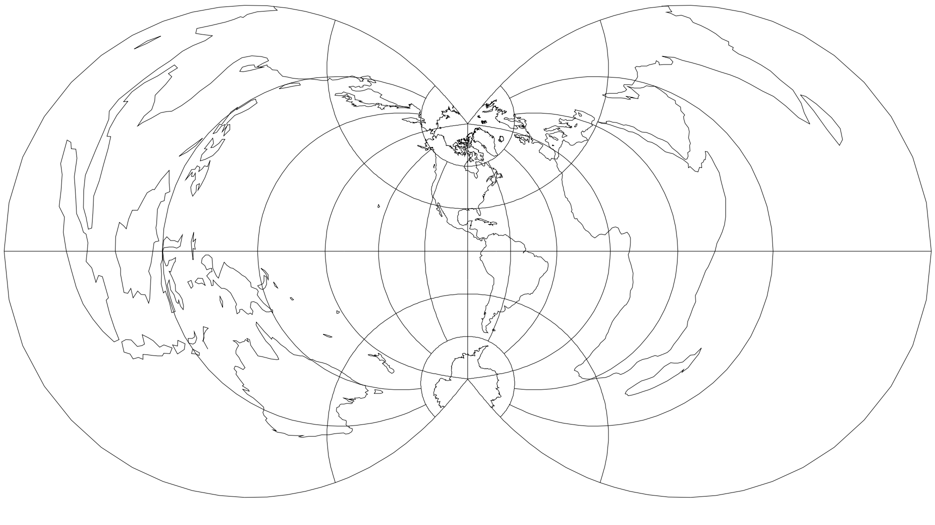

Figure 44: Rectangular Polyconic projection, with shorelines and 30° graticule. Central Meridian 90° W. North and south latitudes of 45° are at true scale. (`+proj=rpoly +lon_0=90w +lat_ts=45`).

Bonne Projection

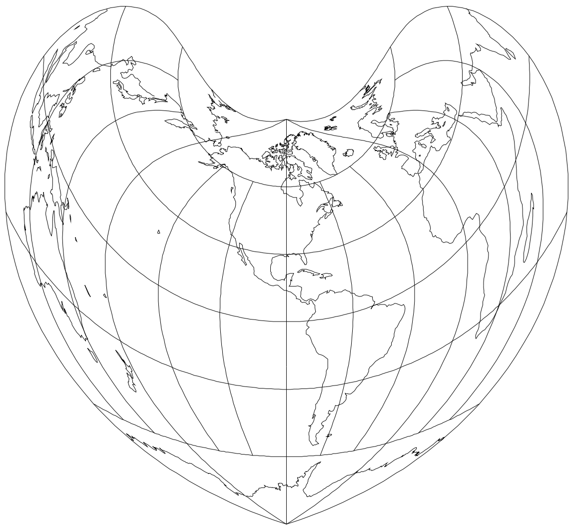

Figure 45: Bonne projection, with shorelines and 30° graticule. Central Meridian 90° W (`+proj=bonne +lon_0=90w`).

Classifications: Pseudoconic. Equal area.

Available forms: Forward and inverse, spherical and elliptical projection.

Usage and options: `+proj=bonne +lat_1=`ϕ_1

Default value for ϕ_1 is 40° N. The Werner projection (figure 46) is a variant of the Bonne where $\phi_1 = \pm 90°$. Parameter `+lat_0` is not employed in this projection and the cartesian origin is at λ_0 and ϕ_1.

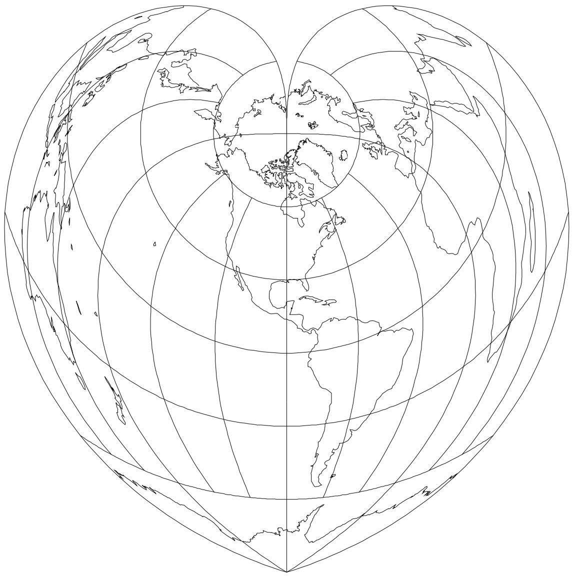

Figure 46: Werner projection, with shorelines and 30° graticule. Central Meridian 90° W (`+proj=bonne +lon_0=90w +lat_1=90n`).

Azimuthal Projections

Azimuthal projections are based upon projections to a plane tangent to the Earth's surface at a point specified by `lon_0=`λ_0 and `lat_0=`ϕ_0. When ϕ is $\pm 90°$ or ϕ is $0°$ the projections are respectively termed polar and equatorial, otherwise they are termed oblique. In all cases, the x–y origin coincides with λ_0–ϕ_0.

Stereographic Projection

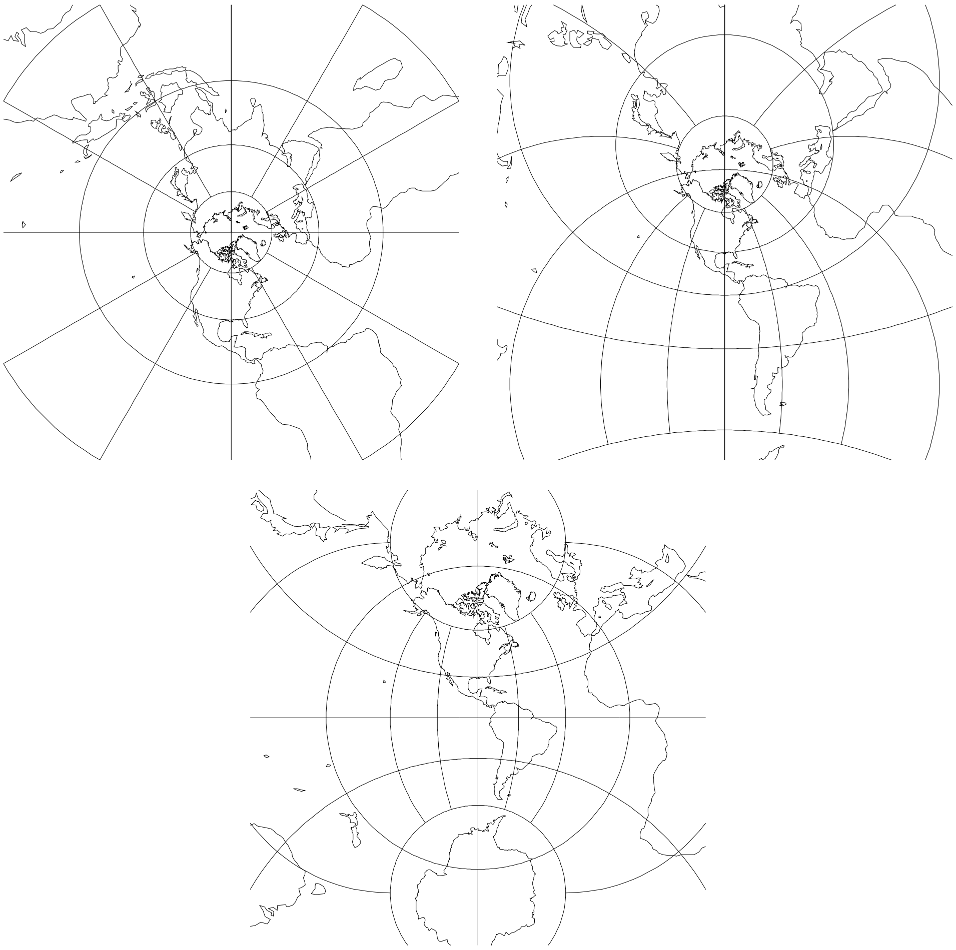

Figure 47: Polar (`lat_0=90`), oblique (`lat_0=45`) and equatorial aspects of the Stereographic projection, with shorelines and 30° graticule. Central Meridian 90° W. (`+proj=stere +lon_0=90w`)

Classifications: Azimuthal. Conformal.

Available forms: Forward and inverse, spherical and elliptical projection.

Usage and options: `+proj=stere +lat_0=`ϕ_0 `+k=`k_0 `+lat_ts=` ϕ_0

The parameter k_0 is the scaling factor at the tangency point of the projection (λ_0, ϕ_0) and is 1. if `+k` is not specified. For the polar aspects, the latitude of true scale, ϕ_s, may be employed in lieu of k_0 when $\phi_s \neq \pm 90°$ (the default value).

Universal Polar Stereographic (UPS) Projection

Usage and options: `+proj=ups +south`

The UPS projection is a special case polar aspect of the Stereographic projection designed to cover the regions where $\phi \geq 84°$ N or $\phi \leq 80°$ S. The internal Stereographic parameters are fixed at $k_0 = 0.994$, $\lambda_0 = 0°$, $x_0 = y_0 = 2,000,000$m, and ϕ_0 is either 90° N when `+south` is not specified or 90° S when `+south` is specified. Elliptical parameters must be used (either *proj* default or entered as option). Also see the Universal Transverse Mercator (UTM) projection (p. 12).

Gnomonic Projection

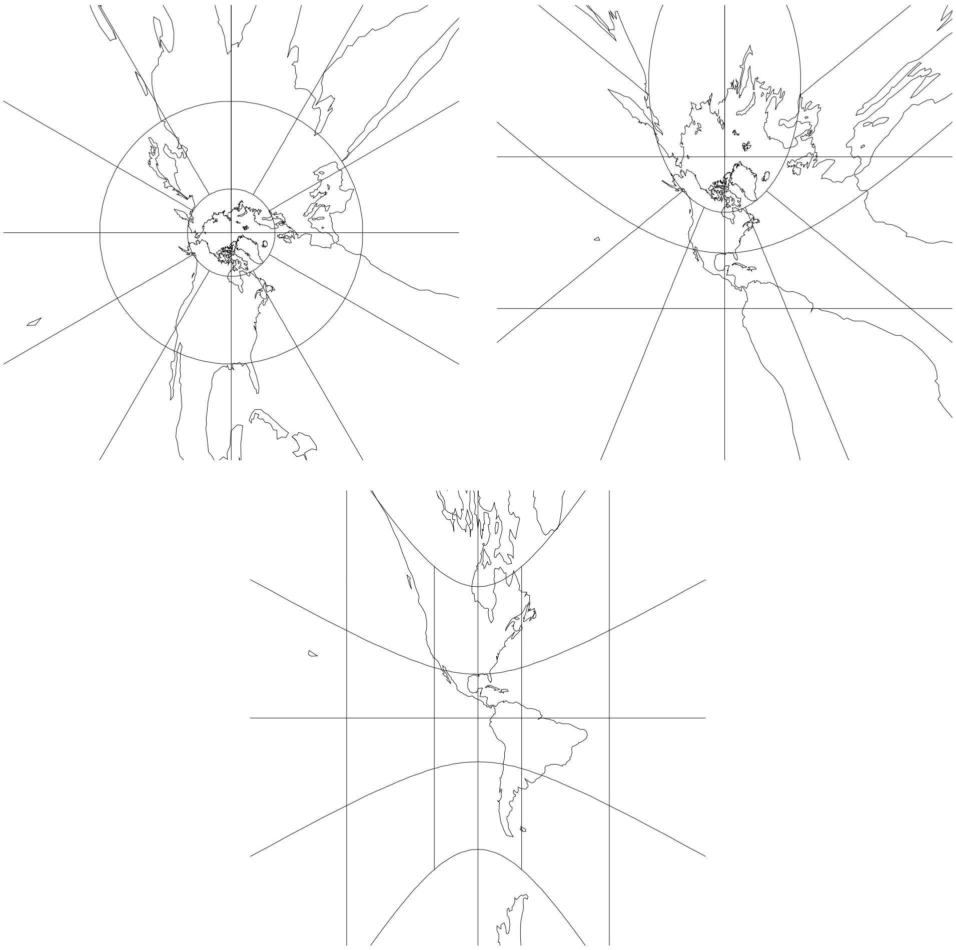

Figure 48: Polar (`lat_0=90`), oblique (`lat_0=45`) and equatorial aspects of the Gnomonic projection, with shorelines and 30° graticule. Central Meridian 90° W. (`+proj=gnom +lon_0=90w`)

Classifications: Azimuthal. Neither confomal nor equal area.

Aliases: Gnomic, Central.

Available forms: Forward and inverse, spherical projection.

Usage and options: `+proj=gnom`

Orthographic Projection

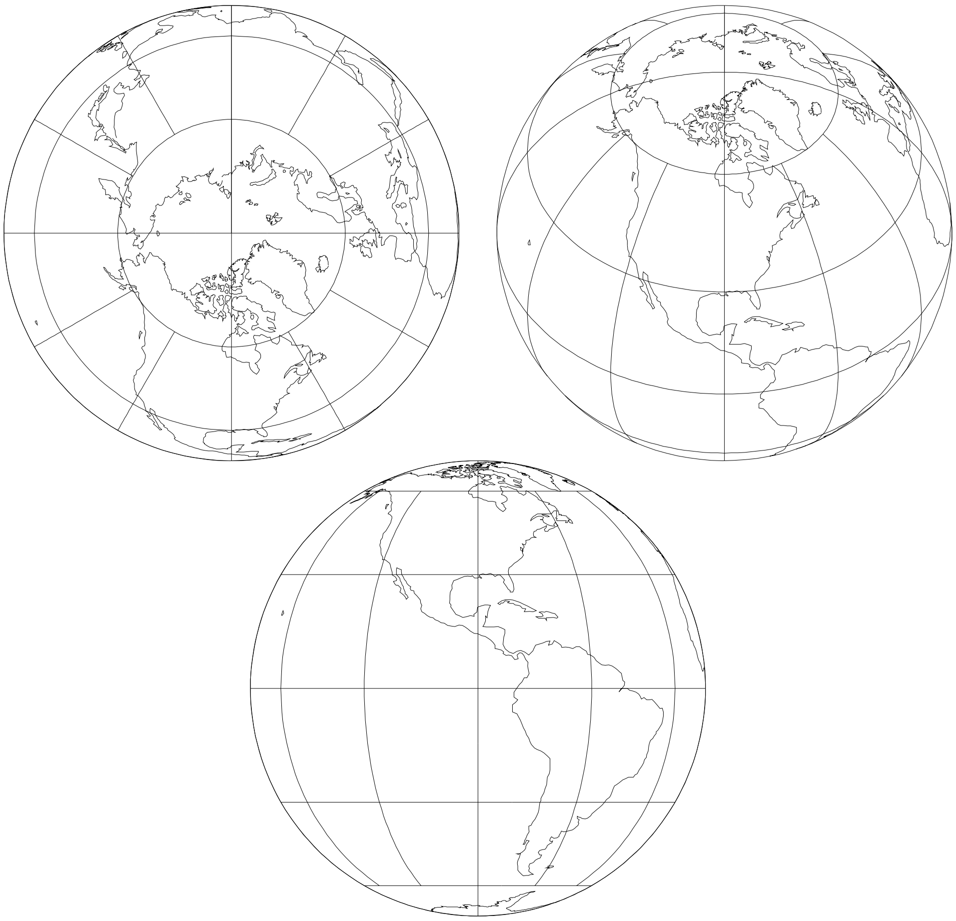

Figure 49: Polar (`lat_0=90`), oblique (`lat_0=45`) and equatorial aspects of the Orthographic projection, with shorelines and 30° graticule. Central Meridian 90° W. (`+proj=ortho +lon_0=90w`)

Classifications: Azimuthal. Neither confomal nor equal area.

Available forms: Forward and inverse, spherical projection.

Usage and options: `+proj=ortho`

Airy Projection

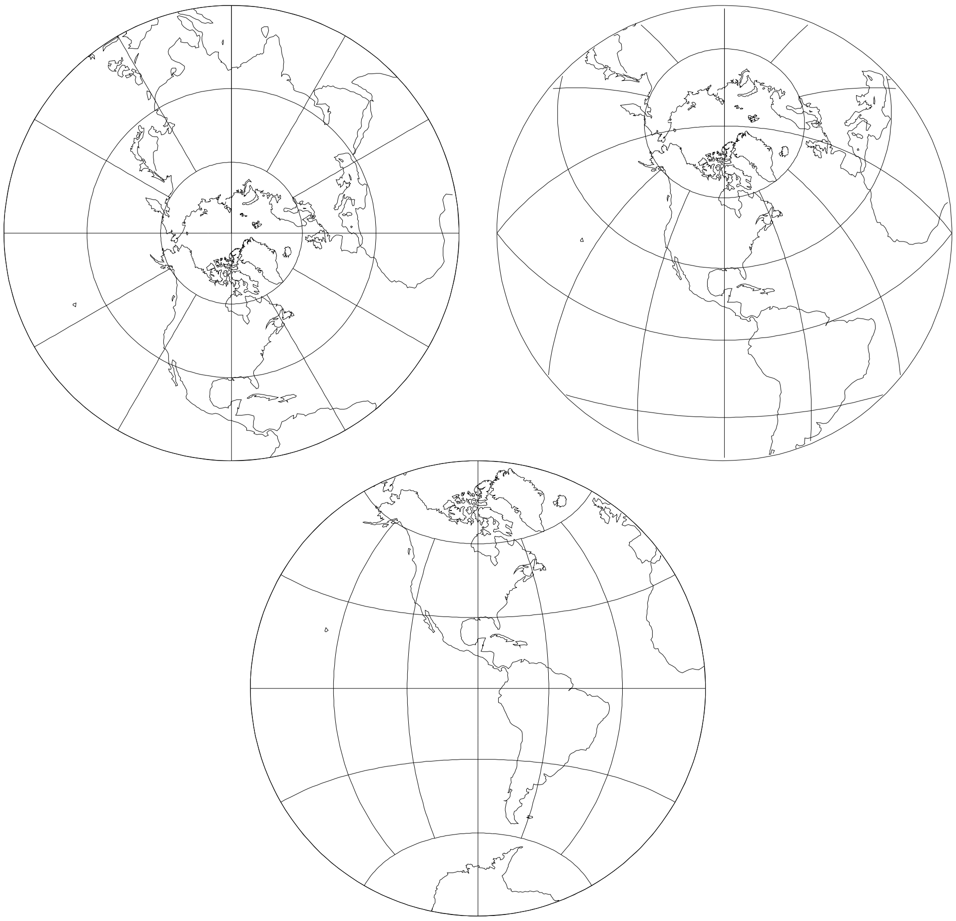

Figure 50: Polar (`+lat_0=90`), oblique (`+lat_0=45`) and equatorial aspects of the Airy projection, with shorelines and 30° graticule. Central Meridian 90° W and $\phi_b = 90°$. (`+proj=airy +lon_0=90w`)

Classifications: Azimuthal. Neither confomal nor equal area.

Available forms: Forward spherical projection.

Usage and options: `+proj=airy +lat_b=`ϕ_b `+no_cut`

The Airy projection is an azimuthal minimum error projection for the region within the small or great circle defined by an angular distance, ϕ_b, from the tangency point of the plane (λ_0, ϕ_0). The default value for ϕ_b is 90° that is suitable for hemispherical maps. Extent of projection is limited to the hemisphere unless `+no_cut` is specified.

Near-Sided Perspective Projection

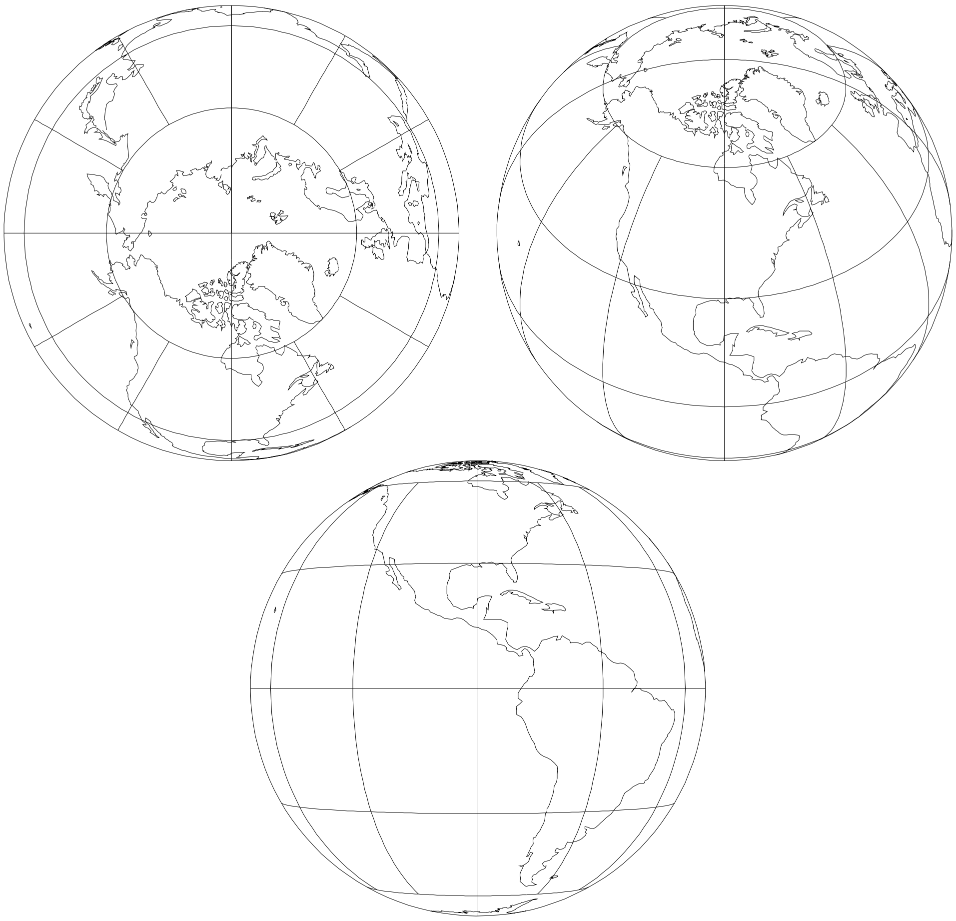

Figure 51: Polar (`lat_0=90`), oblique (`lat_0=45`) and equatorial aspects of the Near-Sided Perspective projection, with shorelines and 30° graticule. Central Meridian 90° W. (`+proj=nsper +lon_0=90w +a=1 +h=8`)

Classifications: Azimuthal. Neither confomal nor equal area.

Available forms: Forward and inverse, spherical projection.

Usage and options: `+proj=nsper +h=`h

Parameter h is the height of the view point above the Earth and must be in the same units as a.

Lambert Azimuthal Equal Area Projection

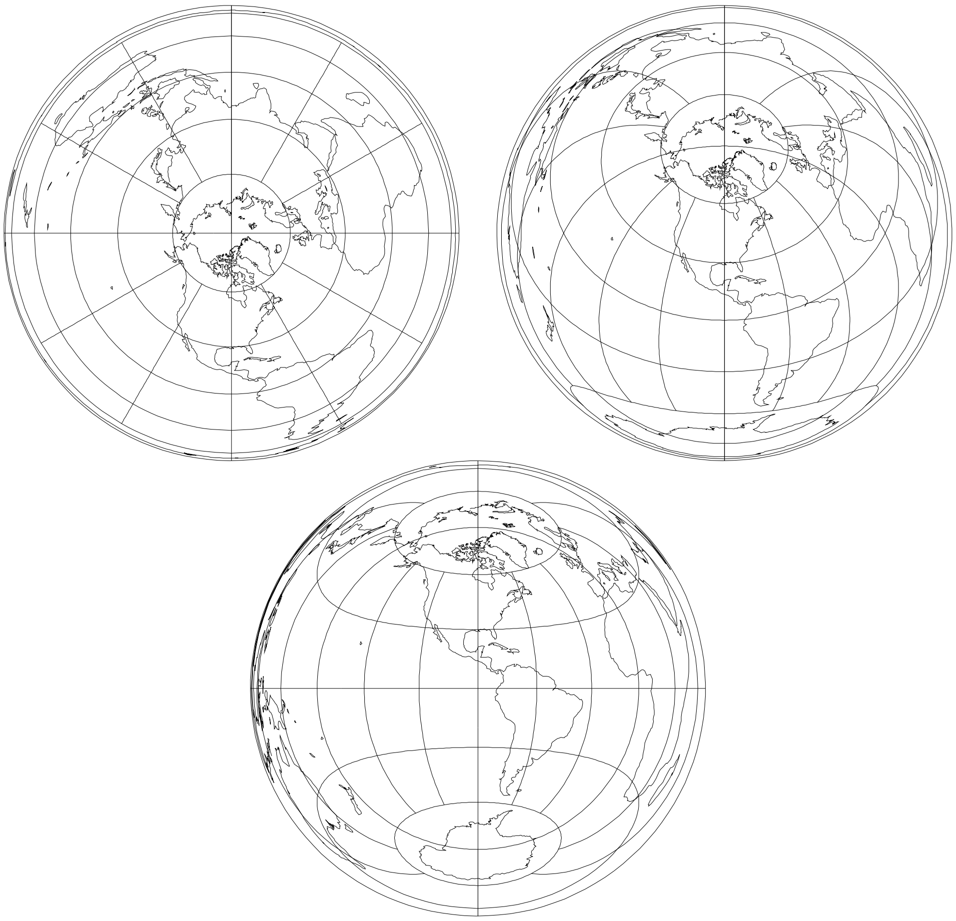

Figure 52: Polar (`lat_0=90`), oblique (`lat_0=45`) and equatorial aspects of the Lambert Azimuthal Equal Area projection, with shorelines and 30° graticule. Central Meridian 90° W. (`+proj=laea +lon_0=90w`)

Classifications: Azimuthal. Equal area.

Aliases: Lorgna, Zenithal Equal-Area, Zenithal Equivalent.

Available forms: Forward and inverse, spherical projection.

Usage and options: `+proj=laea`

Azimuthal Equidistant Projection

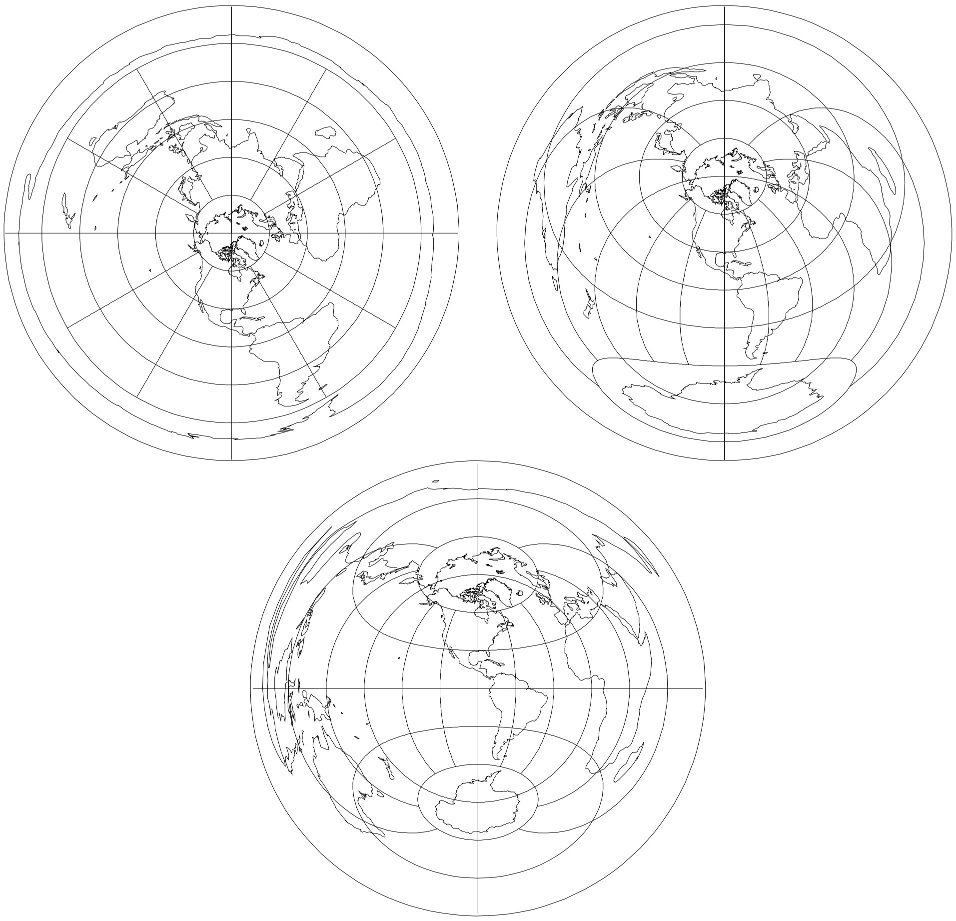

Figure 53: Polar (`lat_0=90`), oblique (`lat_0=45`) and equatorial aspects of the Azimuthal Equidistant projection, with shorelines and 30° graticule. Central Meridian 90° W. (`+proj=aeqd +lon_0=90w`)

Classifications: Azimuthal. Neither confomal nor equal area.

Aliases: Postel, Zenithal Equidistant.

Available forms: Forward and inverse, spherical projection.

Usage and options: `+proj=aeqd`

Hammer Projection

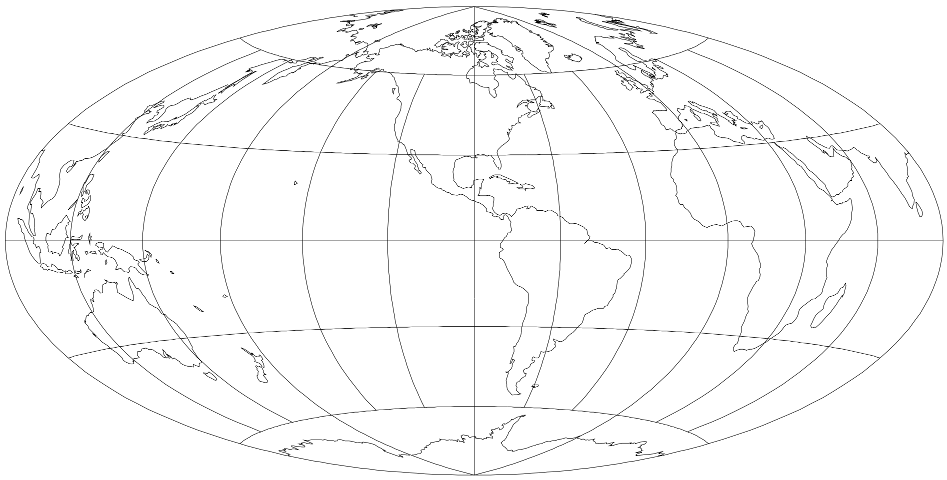

Figure 54: Hammer projection, with shorelines and 30°graticule. Central Meridian 90° W. (`+proj=hammer +lon_0=90w`)

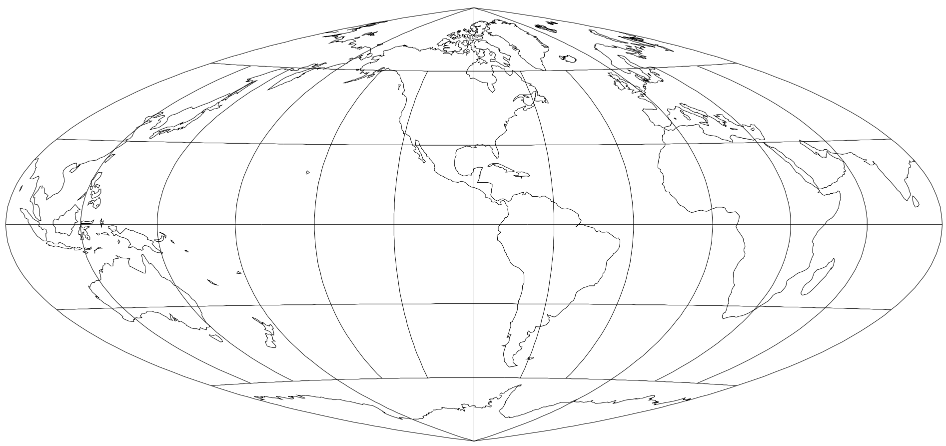

Figure 55: Eckert-Greifendorff modified Hammer projection, with shorelines and 30° graticule. Central Meridian 90° W. (`+proj=hammer +lon_0=90w +W=.25`)

Classifications: Modified azimuthal, equal area.

Aliases: Hammer-Aitoff (also erroneously called Aitoff).

Available forms: Forward, spherical projection.

Usage and options: `+proj=hammer [ +W=`n` ]`

The real value n assigned to the `+W` option determines the normal Hammer projection, $n = 0.5$ or `+W` option omitted, shown in figure 54, the Eckert-Greifendorff, $n = 0.25$, projection shown in figure 55. A value of $n = 0$ is a terminal error.

Wagner VII Projection

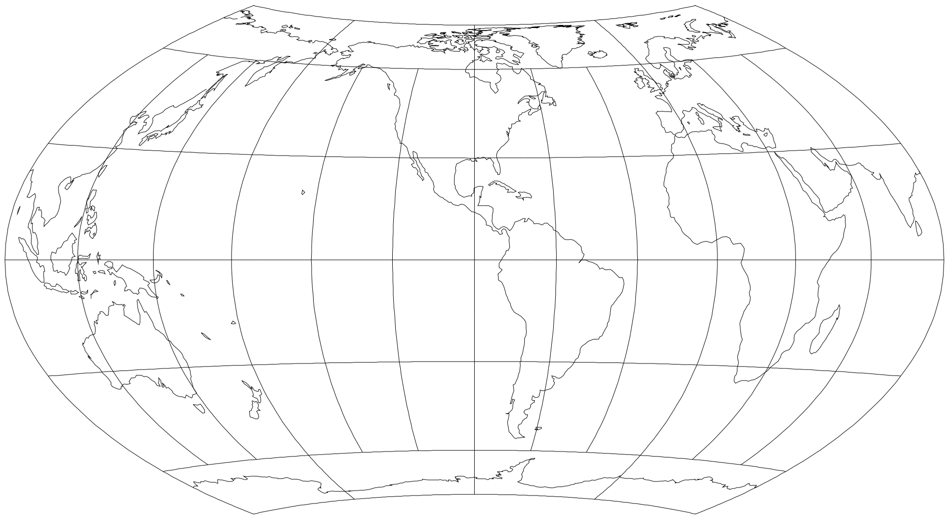

Figure 56: Wagner VII projection, with shorelines and 30° graticule. Central Meridian 90° W. (`+proj=wag7 +lon_0=90w`)

Classifications: Modified azimuthal. Equal area.

Aliases: Hammer-Wagner.

Available forms: Forward, spherical projection.

Usage and options: `+proj=wag7`

Aitoff Projection

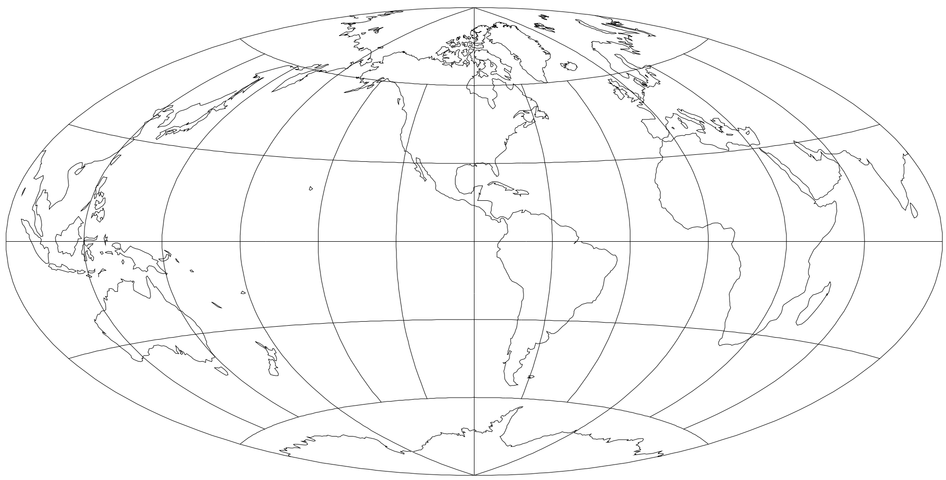

Figure 57: Aitoff projection, with shorelines and 30°graticule. Central Meridian 90° W. (`+proj=aitoff +lon_0=90w`)

Classifications: Modified azimuthal. Neither conformal nor equal area.

Available forms: Forward, spherical projection.

Usage and options: `+proj=aitoff`

Winkel Tripel Projection

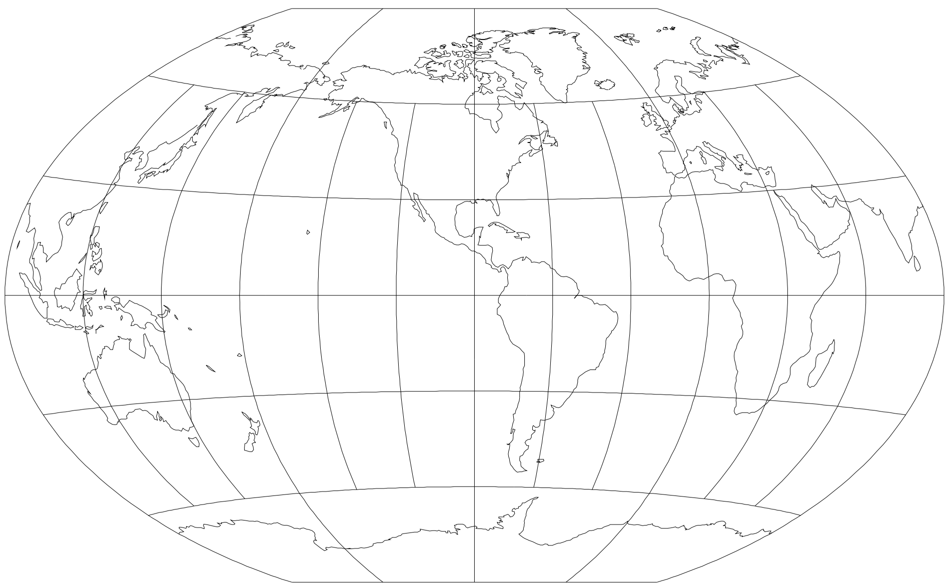

Figure 58: Winkel Tripel projection, with shorelines and 30° graticule. Central Meridian 90° W. (`+proj=wintri +lon_0=90w`)

Classifications: Modified azimuthal. Neither conformal nor equal area.

Available forms: Forward, spherical projection.

Usage and options: `+proj=wintri`